

The University of Chicago

A COMPARATIVE STUDY
OF SCALES CONSTRUCTED BY THREE
PSYCHOPHYSICAL METHODS

A PART OF A DISSERTATION SUBMITTED TO
THE FACULTY OF THE DIVISION OF THE
BIOLOGICAL SCIENCES IN CANDI-
DACY FOR THE DEGREE OF DOC-
TOR OF PHILOSOPHY

DEPARTMENT OF PSYCHOLOGY
1935

By
MILTON A. SAFFIR

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A COMPARATIVE STUDY OF SCALES CONSTRUCTED BY THREE PSYCHOPHYSICAL METHODS*

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A comparison is made between the scales constructed by the Method of Paired Comparison, Rank Order, and the Method of Successive Intervals. Application of the three psychophysical methods to handwriting specimens and to nationality preferences results in mutually linear scales. Choice of scaling methods becomes, then, a matter of practical convenience rather than of relative validity.

The object of this study is to compare, on the basis of empirical data, the scales constructed through the use of the Method of Paired Comparison, the Rank Order Method, and the Method of Successive Intervals. All of these are developments of the traditional psychophysical methods which have made it feasible to construct scales for the quantitative study of psychological values that can not be objectively measured, such as social attitudes, nationality preferences, handwriting excellence, etc.

Since the psychological continua represented by attitude, preference, and judgment scales can not be directly measured, the validation of the psychophysical methods used in constructing the scales has depended upon a measure of the internal consistency in the method employed. With the Method of Paired Comparison, for example, the discrepancies between experimentally observed proportions and those calculated through the use of the scale values is such a measure of internal consistency. If we can allocate 25 stimuli along a linear scale in such a way that the 25 points account for some 300 experimental observations, within the limits of chance error, then we have grounds for using that scale to represent the psychological process responsible for the data.

We can further study the validity of a psychophysical method by comparing a scale constructed according to it with one constructed through the use of a different psychophysical method. While this does not constitute a final proof that either scale is valid for the purpose

*The writer is very much indebted to Professor L. L. Thurstone for the suggestion of this problem and for supervision in carrying out the study.

for which we propose to use it, yet if the two scales were comparable we could use both methods with increased confidence. If on the other hand the two scales were not comparable, we would find it necessary to determine which method was most valid for the description of the discriminatory process in question.

Miss Hevner (1) has carried through such a study of the Methods of Paired Comparison, Order of Merit (Rank Order Method) and Equal Appearing Intervals. She found that the scale values obtained through the use of the Method of Paired Comparison when plotted against those calculated from data from the Order of Merit Method, gave a linear plot, indicating that they were comparable. The scale values obtained by the Method of Equal Appearing Intervals when compared with those from the other two methods, gave plots which were not linear, indicating that the scales were not comparable. She concluded that scales constructed by the Paired Comparison Method or the Order of Merit Method were more dependable than those constructed by the Method of Equal Appearing Intervals, because the former corroborated each other, because in them the internal consistency could be demonstrated, because the latter was subject to error through the "end effect", and because the latter does not involve a test of internal consistency.

It should be pointed out that the agreement of the Methods of Paired Comparison and Order of Merit in Miss Hevner's study is not a check on the validity of the psychophysical methodology involved, since the same psychophysical process, Case V of Thurstone's Law of Comparative Judgment, was applied to the data obtained by both methods. All that was demonstrated was that the data obtained from the subjects' ranking the stimuli were comparable with the data obtained from the subjects' comparing each stimulus with every other one. Even if the logic used in deriving Thurstone's Law were so faulty as to invalidate its use in deriving a scale, Miss Hevner's results would still show the same close agreement between the two methods of gathering data which she employed. Therefore no judgment as to the validity of the scale values obtained from the data is justified by the agreement of scale values in her study.

The present investigation makes use of a new psychophysical process, the Method of Successive Intervals, which is entirely independent in its logic. This process, developed by Thurstone, is applicable to data gathered by the Method of Equal Appearing Intervals, takes account of the "end effect", and involves a test of internal consistency. It will be shown in this paper that this process is applicable

to data obtained by the Order of Merit Method, or, more properly, that the latter method can be treated as the special case of the Method of Successive Intervals in which the number of intervals is equal to the number of stimuli. We can compare the scales obtained from such an application with those obtained by Miss Hevner from the same data. Thus we can compare the scales which result from two different processes applied to a single set of data.

The present study, then, will deal with three methods of gathering data, and with two statistical procedures for treating the data. The comparisons will be between the scales resulting from the following four combinations:

- (1) Paired Comparison data treated according to the Law of Comparative Judgment;
- (2) Order of Merit data treated according to the Law of Comparative Judgment;
- (3) Order of Merit data treated according to the Method of Successive Intervals;
- (4) Equal Appearing (or Successive) Interval data treated according to the Method of Successive Intervals.

In addition to Miss Hevner's data dealing with judgments of excellence of handwriting specimens, a new set of data has been collected dealing with nationality and racial preferences. This makes it possible to compare the two psychophysical processes as applied to two different sorts of material, involving psychological activities that are quite distinct from each other.

Gathering The Data

1. The Stimuli and the Subjects.

In order to proceed with a comparison of the various psychophysical methods, it is necessary to use the same subjects and the same stimuli for each of the methods. In Miss Hevner's experiment the stimuli consisted of twenty specimens of handwriting, ranging from very poor to very excellent. Each of the 370 graduate and undergraduate students who served as subject was given some instruction as to the methods of judging the specimens, and then compared them according to the methodology of the three procedures — the Method of Paired Comparison, the Method of Equal Appearing Intervals, and the Order of Merit Method. These methods will be described below.

In the present experiment the stimuli consisted of the following 25 nationality and racial groups: American, Austrian, Belgian, Cana-

dian, Chinese, Englishman, Frenchman, German, Greek, Hindu, Hollander, Irishman, Italian, Japanese, Jew, Mexican, Negro, Norwegian, Pole, Russian, Scotchman, South American, Spaniard, Swede, and Turk. Nationality preference scales have been constructed by psychophysical methods a number of times, (2, 3), and, as Thurstone has pointed out, the names of the above groups are valid psychological stimuli regardless of the questions that might be raised as to the genuineness of each as an ethnological unit.

In constructing a scale of nationality preferences, it is desirable to choose as homogeneous a population as possible. For this reason it was decided to use as subjects only native born, white Christians whose parents were also native born white Christians. Approximately 1000 sets of materials were distributed to University of Chicago undergraduate students in the elementary psychology and social science courses. Each set contained a paired comparison schedule and cards for the successive interval and rank order methods. The subjects were instructed to complete the materials for one method before beginning the second. They might sign their names or not, as they preferred. Of all the materials distributed, less than 400 sets were returned, and of these it was necessary to eliminate about two-thirds because of incompleteness or because the student was of Negro, Jewish, or foreign-born parentage. One hundred thirty-three returns were suitable according to the criteria that had been set up, and these were the only ones used in this study.

2. *Method of Paired Comparison.*

In the Method of Paired Comparison, which is the more complete form of the traditional Constant Method or Method of Right and Wrong Cases, the subjects compare each stimulus with every other one. For n stimuli there will be $\frac{n(n-1)}{2}$ comparisons for each subject to make.

In the present study there were 300 pairs of nationalities on the paired comparison schedule.* In order that the data may be treated by some form of Thurstone's Law of Comparative Judgment, it is necessary that the subjects make a choice in each pair of stimuli, indicating that one is preferred to the other. Even where the two stimuli are psychologically very close together, so that they appear to the subject as just about equal, it is still necessary to make a choice—even if it appears to be more of a guess than a judgment. If the stimuli were actually

*Through a clerical error the combination Irishman-South American was omitted and Italian-South American appeared twice. The same number of subjects underlined each member of this pair at both places.

equal, and there were a large number of subjects who were compelled to make a choice, the laws of chance would operate, so that stimulus A would be preferred to stimulus B about as often as the reverse.

When all the schedules had been returned, the data were tabulated by counting the number of times each member of the 300 pairs of nationalities was underlined. Thus for the first combination, Japanese-Austrian, it was found that 16 subjects had underlined Japanese, 115 had underlined Austrian, and 2 had underlined neither. From this tabulation it was a simple step to prepare Table I which gives the proportion of the subjects which preferred each nationality to each one of the others.

3. Method of Successive Intervals.

The essential procedure in the Method of Successive Intervals is for the subject to sort the stimuli into a series of piles or groups, representing a succession of quantitative or qualitative values. This method is a more general form of the Method of Equal Appearing Intervals, in which the subjects follow the above sorting procedure with the additional condition that the piles must be so spaced as to form apparently equal steps or intervals. Data obtained through the more limited method can, of course, be treated by the successive interval procedure.

It is much easier for a subject to follow a sorting procedure if he has a fairly large number of specimens to sort, than if he has only two or three specimens to place in each pile. Hence in both Miss Hevner's and the present study, a good many additional stimuli were mixed with those used in the paired comparison part of the experiment. The subject was presented with all the stimuli in the same way, though the scale values were to be calculated for only the twenty or twenty-five that were used in the other methods.

Miss Hevner presented her subjects with 72 specimens of handwriting, instructing them to sort the samples into eleven piles in such a way that the difference in excellence represented by the interval between any two successive piles were the same. For each of the specimens she counted the frequency with which it was placed in each of the eleven piles. It is from these data that the scale values were recalculated in the present study.

The scaling procedure used by Miss Hevner for these data was quite simple. From the frequency distribution for each specimen a cumulative frequency curve was plotted, and the median, the point at which the curve crossed the 50% line, was read directly from the graph. These scale values are subject to the various criticisms listed

in Miss Hevner's conclusions which are quoted at the beginning of this paper.

To secure the successive interval data for the nationality preference study, the names of the twenty-five races and nationalities used in the paired comparison schedule were printed on separate cards, and in order to facilitate the sorting procedure for the subjects, there were added cards with the names of 35 additional groups. These materials were enclosed in a heavy manila envelope which was distributed to the subjects along with the paired comparison schedules. Enclosed in the envelope was the instruction sheet which asked the subjects to sort the nationalities into ten piles, placing in pile 1 those with which he would most prefer to associate, in pile 2 those which were a little less preferable, etc. To secure rank order data, the subjects were further instructed to number the nationalities in each pile in the order of preference.

The successive interval data was tabulated by counting the number of times each nationality was placed in each of the ten piles. Table II contains the frequency distribution for each of the twenty-five nationalities.

4. *Rank Order Method.*

The procedure in the Order of Merit or Rank Order Method is the simplest of all so far as the instructions to the subject are concerned. He is presented with a list of stimuli which he is told to put in rank order according to a given criterion. In Miss Hevner's study the subjects were told to rank the handwriting specimens in the order of their general excellence. As described above, instructions for ranking were included with the successive interval materials, in the nationality preference study. So many of the subjects, however, overlooked this part of the procedure, that as a result no rank order data are available for the nationality preference materials.

The tabulation of the rank order data depends on the statistical process which is to be applied. In Miss Hevner's study the Law of Comparative Judgment was used, so that it was necessary to construct a table of paired comparisons — that is, to determine the number of times each stimulus had been ranked more favorably than each of the other stimuli. This sort of a tabulation from rank order data is very laborious. If a subject rated the specimens $a, b, c, d, \dots$ it was tabulated as a preferred to b , a preferred to c , a preferred to d , b preferred to c , b preferred to d , c preferred to d , etc. This sort of tabulation for the twenty stimuli had to be made separately for the rankings of each of the 370 subjects. From this point on Miss Hevner's

procedure was identical with her procedure in treating the data obtained by the Paired Comparison Method.

In a paper (5) published subsequent to Miss Hevner's study, Thurstone has developed a statistical technique for converting the raw data gathered by the rank order method into the paired comparison table necessary for the application of some form of the Law of Comparative Judgment. This method is much easier than the laborious counting procedure employed by Miss Hevner, and gives results that are very close approximations to those which she obtained. Thurstone calculated a set of scale values from Miss Hevner's data, using his shorter method, and found them almost identical with her scale values.

In the present study it was proposed to treat the rank order data by some method other than the Law of Comparative Judgment, used in both Miss Hevner's and Thurstone's papers. This was done by applying the statistical procedure of the Method of Successive Intervals, which is made possible by treating each absolute rank as an interval, so that there are as many piles as there are stimuli. Thus in applying this method to the Hevner data, we treat the material as if there were twenty piles, and each subject placed a single specimen in each pile. If a subject ranked the stimuli $a, b, c, d, \dots$ it was treated as a case in which specimen a was placed in pile 1, specimen b in pile 2, specimen c in pile 3, etc. In tabulating the data in such a fashion we are finding the number of times stimulus a was ranked first, second, third, etc., and similarly for stimuli b, c , and each of the others. Such a tabulation is, of course, much easier to make than Miss Hevner's tabulation through counting. It is the first step according to Thurstone's simplified procedure.

Statistical Treatment of the Data

1. The Law of Comparative Judgment.

The Law of Comparative Judgment was first described by Thurstone in 1927 (4). Five cases of the law were described, differing in the number of assumptions that are made. In both Miss Hevner's and the present study, Case V, the simplest form of the Law of Comparative Judgment was used. This form, in addition to the assumptions made by the other cases, assumes that the discriminial dispersions for all the stimuli used are equal. The statistical form of Case V is:

$$S_1 - S_2 = x_{12}\sqrt{2}\sigma, \text{ in which,}$$

S_1 and S_2 are the scale values of stimuli 1 and 2, respectively
 x_{12} is the sigma value corresponding to the observed propor-

tion of judgments "Stimulus 1 is greater than stimulus 2"

σ is the stimulus dispersion, assumed to be equal for all stimuli.

In order to use all the data, the above formula was converted to

$$S_1 - S_2 = \frac{\sum (x_{1k} - x_{2k})}{n},$$

in which the subscript k denotes each stimulus taken in turn, n is the number of stimuli for which x_{1k} and x_{2k} were used, and the unit of measurement is $\sqrt{2} \sigma$. The scale separation between each successive pair of nationalities was calculated from this formula. The arbitrary origin of the scale was set at the lowest nationality, Turk, and from the scale separations the scale value of each nationality was determined. Column two of Table III contains the scale values obtained for each of the twenty-five nationalities.

Having obtained the scale values, it is next necessary to check the internal consistency — that is, the extent to which the scale values account for the complete table of proportions. This can be done very simply by using the scale values as starting points, and reversing the whole process to arrive at a set of calculated proportions which may be compared with the experimental proportions. Since we now know the scale values, we can calculate the value of x_{12} in the equation:

$$S_1 - S_2 = x_{12},$$

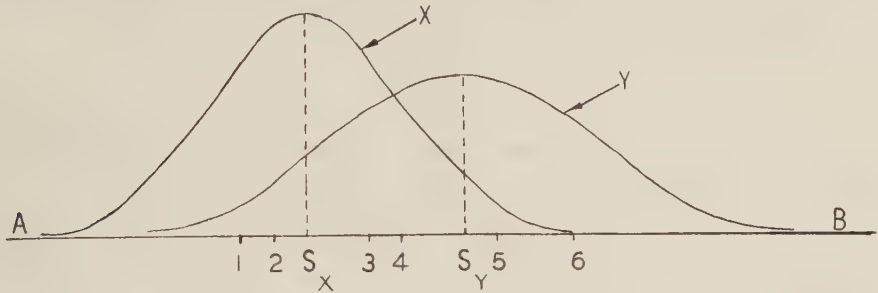
and with the use of the probability table, this value may be converted into the corresponding proportion. This is done for every pair of nationalities. The average discrepancy between the calculated and the original experimental proportions for the entire table was .031.

Miss Hevner used exactly the same procedure as has just been described in calculating the scale separations and final scale values for both her paired comparison and order of merit data. The scale values obtained by her are listed in columns two and three of Table IV. In checking the internal consistency as described above, Miss Hevner found an average discrepancy of .024 for the paired comparison data, and .012 for the order of merit data.

2. *Method of Successive Intervals.*

The statistical procedure for calculating the scale values by the Method of Successive Intervals has been described by Thurstone in his lectures, but has not yet been published.

The fundamental conditions in the method are as follows: The psychological scale is by definition such that the frequency distribution of the discriminial processes for each stimulus is normal. The discriminial dispersion (the standard deviation of each of the frequency distributions) varies for each stimulus. The scaling problem consists in determining the modal discriminial process for each stimulus. We have given a frequency distribution for each stimulus in terms of a given number of piles, the piles being successively, though not necessarily equally, spaced along the psychological scale.



The diagram above illustrates the problem. The line AB represents the psychological continuum. It is defined so that the curves x , y , $\dots$ are normal. Points 1, 2, $\dots$ represent the successive piles; the distance between them is unknown. The scaling problem consists of allocating S_x , S_y , $\dots$ along AB. We are given the proportions for each stimulus corresponding to each one of the piles.

It is a simple step to determine the scale so that the distribution of x is normal; we simply read off the sigma values corresponding to the given cumulative proportions. If 25% of the subjects place stimulus x in pile 1, then point 1 will be located .67 sigma from S_x . In a similar manner we obtain the sigma values for the other piles.

Let us now follow a similar procedure with the cumulative proportions of distribution y . Since the psychological continuum is the same, the relative distances between the piles will remain the same, no matter what distribution is used. Two factors, aside from chance errors, will operate to change the sigma-values for points 1, 2, etc. Since the sigma-value for pile 1 obtained from distribution x gives its distance from S_x , and that obtained from distribution y gives its distance from S_y , the two values will differ by the distance $S_x - S_y$. This distance is a constant that is added to the sigma-value for each pile when it is obtained from distribution y rather than x .

The second factor which causes the sigma-value for the same point to vary with the distribution used, is the fact that the unit of measurement is the sigma of the particular distribution used; if σ_x is twice σ_y , then the sigma-value obtained for pile 1 from distribution x will be half that obtained from distribution y . If we plot the two sets of sigma values on a graph we will obtain a linear distribution, since the values are proportional to each other. The first factor mentioned above will be reflected in the fact that the curve will not pass through the origin; there will be a y -intercept equal to the difference $S_x - S_y$ in terms of σ_y as the unit. The second factor will be reflected in the slope of the line which will express the ratio of σ_x to σ_y .

The equation of a straight line is:

$$y = ax + b. \quad (1)$$

If we fit this curve to our data for distributions x and y by the method of averages, the line will pass through the points

$$\frac{\Sigma x_1}{n_1}, \frac{\Sigma y_1}{n_1}, \text{ and } \frac{\Sigma x_2}{n_2}, \frac{\Sigma y_2}{n_2}$$

so that the equation will take the form:

$$y = \frac{\frac{\Sigma y_1}{n_1} - \frac{\Sigma y_2}{n_2}}{\frac{\Sigma x_1}{n_1} - \frac{\Sigma x_2}{n_2}} x + b, \quad (2)$$

which reduces to

$$y = \frac{n_2 \Sigma y_1 - n_1 \Sigma y_2}{n_2 \Sigma x_1 - n_1 \Sigma x_2} x + b. \quad (3)$$

Since the slope of this curve is equal to the ratio $\frac{\sigma_x}{\sigma_y}$, we have

$$\frac{\sigma_x}{\sigma_y} = \frac{n_2 \Sigma y_1 - n_1 \Sigma y_2}{n_2 \Sigma x_1 - n_1 \Sigma x_2}. \quad (4)$$

Solving for σ_y , we have

$$\sigma_y = \frac{\sigma_x (n_2 \Sigma x_1 - n_1 \Sigma x_2)}{n_2 \Sigma y_1 - n_1 \Sigma y_2}, \quad (5)$$

from which we can determine the value of σ_y by making σ_x the unit of measurement, calling it 1.

We can also write (1) in the form

$$y = \frac{\sigma_x}{\sigma_y} x + b. \quad (6)$$

Solving for b we have

$$b = y - \frac{\sigma_x}{\sigma_y} x. \quad (7)$$

But since

$$b = \frac{S_x - S_y}{\sigma_y} \quad (8)$$

we have, passing the curve through $\frac{\Sigma x_1}{n_1}, \frac{\Sigma y_1}{n_1}$,

$$\frac{S_x - S_y}{\sigma_y} = \frac{\Sigma y_1}{n_1} - \frac{\sigma_x}{\sigma_y} \frac{\Sigma x_1}{n_1}. \quad (9)$$

This reduces to

$$S_y = S_x + \frac{\sigma_x \Sigma x_1 - \sigma_y \Sigma y_1}{n_1}. \quad (10)$$

Since our scale must have some arbitrary origin, let us set it at S_x by equating it to 0. We can now solve (10) for S_y . Knowing σ_y and S_y we can set up equations analogous to (5) and (10) for determining σ_z and S_z , and so on for each of the stimuli. We have thus a method for determining the scale value and stimulus dispersion for each of the stimuli used. The unit of measurement is σ_x , and the scale has its arbitrary origin at S_x .

There is, moreover, a check on the original assumption that the intervals between the piles could be so adjusted that all the distributions are normal. This will constitute a check of internal consistency. Since we know the sigma-value for each pile in each distribution, we can obtain the interval between any two piles for each distribution. We can reduce the intervals from all the distributions to a common unit, since the values of all the σ 's are known in terms of σ_x . If our assumptions are correct, the intervals 1-2, 2-3, etc. will not differ markedly in the different distributions.

The scale values and stimulus dispersions obtained according to this method for the nationality preference data have been listed in columns 3 and 4 of Table III, those obtained from Miss Hevner's Order of Merit and Equal Appearing Intervals data appear in columns 4 to 7 of Table IV.

In each case in which the Method of Successive Intervals was used, the check on internal consistency mentioned above was made. There were few marked deviations in the several determinations of

the width of each of the piles ; this bears out our fundamental assumption, that by allocating each pile to a definite position on the scale the distributions of all the stimuli become normal.

Comparison of the Results

Having obtained two sets of scale values for the nationality preference data (Table III) and four sets of scale values for the data from Miss Hevner's handwriting study (Table IV), the final step consists of comparing these sets graphically. Figure I provides a graphical comparison of the two scales obtained for the nationality preference study. Figures II-VII provide comparisons between the scales obtained for the handwriting study.

It is obvious from an inspection of these graphs, that the relationship between any two sets of scale values is a linear one. In several of the graphs there is very little scatter of the points; in others the scatter is somewhat wider, but in all of them the relationship is clearly a linear one. In several of the graphs the points at either extreme do not fall in a straight line, but it should be borne in mind that the end points are based on very few overlapping cases, and are thus unreliable.

Since the scatter of points is due to chance errors, it would be expected that there would be least scatter where there was least opportunity for chance errors. This would be expected for the graph of the two scales which involved only a single set of data. Inspection of Figure V indicates that the plot shows the least deviation or scatter of any of the graphs.

On the basis of the linearity of all the plots, we may conclude that all the methods employed in this study produce equally valid scales. Since the three different methods of gathering data—the Method of Paired Comparison, Order of Merit Method, and Method of Successive Intervals, — and the two different psychophysical techniques for scaling the raw data—the Law of Comparative Judgment and the Method of Successive Intervals — produce comparable scales, we may use any one with considerable confidence. In setting up a problem involving scaling, the choice of methods can be governed by matters of convenience, rather than by questions of relative validity.

It is of some practical interest to discover that the Order of Merit procedure in gathering data combined with the Method of Successive Intervals in treating the raw data, gives a scale comparable with any of the others. The material set-up as well as the labor on the part of

the subjects for a paired comparison study is great, and where the number of stimuli is large, is almost prohibitive. The Order of Merit Method where there are less than thirty stimuli, and the Method of Successive Intervals where there are more than thirty seem to be the most convenient methods of gathering data.

The use of the Law of Comparative Judgment — even when Case V, the simplest form, is employed — is more laborious than the technique of the Method of Successive Intervals. For rank order data, even with Thurstone's shortcut for converting the data into a paired comparison table, it is less laborious to employ the Method of Successive Intervals than the Law of Comparative Judgment.

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TABLE I
Proportion of Subjects which Preferred Nationality at Head of Each Column to Nationality in Each Row

	American	Austrian	Belgian	Canadian	Chinese	Englishman	Frenchman	German	Greek	Hindu	Hollander	Irishman	Italian	Japanese	Jew	Mexican	Negro	Norwegian	Pole	Russian	Scotchman	So. American	Spaniard	Swede	Turk
American		.030	.008	.060	.000	.106	.015	.053	.015	.023	.008	.091	.015	.008	.015	.015	.015	.023	.023	.008	.098	.015	.023	.038	.000
Austrian	.970		.556	.931	.068	.947	.679	.880	.105	.120	.636	.805	.242	.122	.203	.135	.060	.682	.241	.256	.842	.223	.271	.659	.000
Belgian	.992	.444		.947	.030	.962	.561	.765	.045	.061	.621	.692	.218	.030	.165	.045	.015	.511	.105	.211	.744	.226	.295	.561	.033
Canadian	.940	.069	.053		.008	.557	.218	.286	.008	.030	.098	.303	.053	.015	.030	.030	.015	.120	.053	.053	.250	.053	.053	.182	.008
Chinese	1.000	.932	.970	.992		1.000	.940	.970	.689	.422	.985	.962	.880	.568	.647	.583	.298	.977	.750	.827	.985	.824	.872	.924	.836
Englishman	.894	.053	.038	.443	.000		.090	.233	.008	.015	.030	.260	.038	.008	.015	.038	.000	.038	.015	.015	.135	.038	.023	.045	.000
Frenchman	.985	.321	.439	.782	.060	.910		.669	.053	.045	.394	.684	.113	.045	.114	.053	.045	.432	.128	.120	.729	.165	.165	.602	.030
German	.947	.120	.235	.714	.030	.767	.331		.023	.023	.242	.451	.120	.008	.038	.045	.000	.308	.053	.076	.485	.083	.121	.188	.000
Greek	.985	.895	.955	.992	.311	.992	.947	.977		.290	.947	.932	.856	.341	.556	.466	.189	.947	.687	.735	.962	.789	.805	.909	.120
Hindu	.977	.880	.939	.970	.578	.985	.955	.977	.710		.955	.947	.932	.585	.712	.586	.368	.977	.786	.856	.985	.856	.895	.910	.353
Hollander	.992	.364	.379	.902	.015	.970	.606	.758	.053	.045		.609	.136	.060	.128	.061	.023	.568	.090	.195	.788	.195	.233	.545	.015
Irishman	.909	.195	.308	.697	.038	.740	.316	.549	.068	.083	.391		.068	.061	.083	.045	.023	.295	.090	.120	.545	.120	.290	.290	.030
Italian	.985	.758	.782	.947	.120	.962	.887	.880	.144	.068	.864	.932		.226	.323	.258	.075	.871	.402	.459	.931	.534	.680	.826	.030
Japanese	.992	.878	.970	.985	.432	.992	.955	.992	.659	.415	.940	.939	.774		.609	.515	.229	.947	.684	.714	.962	.833	.895	.917	.254
Jew	.985	.797	.835	.970	.353	.985	.886	.962	.444	.288	.872	.917	.677	.391		.432	.173	.932	.526	.591	.970	.684	.795	.880	.235
Mexican	.985	.865	.955	.970	.417	.962	.947	.955	.534	.414	.939	.955	.742	.485	.568		.260	.932	.684	.759	.970	.802	.835	.902	.188
Negro	.985	.940	.985	.985	.702	1.000	.955	1.000	.811	.632	.977	.977	.925	.771	.827	.740	.260	.985	.818	.870	1.000	.893	.908	.947	.580
Norwegian	.977	.338	.489	.880	.023	.962	.568	.692	.053	.023	.432	.705	.129	.053	.068	.068	.015		.121	.135	.662	.203	.143	.538	.015
Pole	.977	.759	.895	.947	.250	.985	.872	.947	.313	.214	.910	.910	.698	.316	.474	.316	.182	.879		.629	.924	.639	.744	.887	.114
Russian	.992	.744	.789	.947	.173	.985	.880	.924	.265	.144	.805	.880	.541	.286	.409	.241	.130	.865	.371		.962	.504	.568	.850	.098
Scotchman	.902	.158	.256	.750	.015	.865	.271	.515	.038	.015	.212	.455	.069	.038	.030	.030	.000	.338	.076	.038		.076	.105	.256	.015
So. American	.985	.677	.774	.947	.176	.962	.835	.917	.211	.144	.805		.466	.167	.316	.198	.107	.797	.361	.496	.924	.466	.803	.098	
Spaniard	.977	.729	.705	.947	.128	.977	.835	.879	.195	.105	.767	.880	.420	.105	.205	.165	.092	.857	.256	.432	.895	.534	.820	.061	
Swede	.962	.341	.439	.818	.076	.955	.398	.812	.091	.090	.455	.710	.174	.083	.120	.098	.053	.462	.113	.150	.744	.197	.180	.053	
Turk	1.000	1.000	.962	.992	.664	1.000	.970	1.000	.880	.647	.985	.970	.970	.746	.765	.812	.420	.985	.886	.902	.985	.902	.339	.947	

TABLE II

Frequency Distribution for each of Twenty-five Nationalities.
Method of Successive Intervals.

Nationality	1	2	3	4	5	6	7	8	9	10
American	127	4	1	1						
Austrian	12	21	30	27	29	7	5	1		1
Belgian	7	43	40	31	8	3	1			
Canadian	77	48	6	2						
Chinese		1	8	5	13	15	18	29	20	24
Englishman	91	38	4							
Frenchman	21	52	36	17	3	1		1		2
German	49	45	29	4	3	2	1			
Greek		5	10	12	19	26	22	19	15	5
Hindu		2	5	5	10	12	16	24	35	24
Hollander	10	45	45	20	8	2	2	1		
Irishman	46	42	29	10	2	2	1		1	
Italian	2	12	26	27	20	22	15	5	3	1
Japanese		1	8	6	14	18	19	24	20	23
Jew	6	12	14	15	11	19	14	15	10	17
Mexican		3	7	10	11	27	26	25	14	10
Negro		3	5	8	4	7	12	12	19	63
Norwegian	9	49	49	19	2	2	2		1	
Pole	3	7	13	27	20	22	18	9	4	10
Russian	2	19	16	17	29	19	14	8	8	1
Scotchman	51	49	25	6	2					
So. American	4	13	15	21	26	24	12	8	9	1
Spaniard	5	5	30	37	29	15	9	3		
Swede	18	48	37	11	11	1	5	1		1
Turk			3	1	3	9	17	24	48	28

TABLE III

Scale Values and Discriminal Dispersions Obtained through the Paired Comparison and Successive Intervals Methods. Nationality Preference Study.

Nationality	Scale Values Paired Comparison Method	Method of Successive Intervals	
		Scale Values	Discriminal Dispersions
American	4.1972		
Austrian	1.7348	2.6971	1.343
Belgian	1.9593	2.2500	.992
Canadian	3.0002	.2728	1.034
Chinese	.4125	5.6501	1.924
Englishman	3.2512	.0000	1.000
Frenchman	2.2020	1.7486	1.201
German	2.5918	1.0284	1.462
Greek	.7126	4.6351	1.609
Hindu	.3243	5.9533	1.965
Hollander	2.0815	2.1279	1.122
Irishman	2.5196	1.1637	1.502
Italian	1.2847	3.4891	1.602
Japanese	.5713	5.5448	1.917
Jew	.8821	4.3902	2.473
Mexican	.6489	5.0213	1.575
Negro	.0383	7.2720	3.219
Norwegian	2.1583	2.0439	1.064
Pole	1.0027	4.1406	1.823
Russian	1.2129	3.6581	1.896
Scotchman	2.5749	.9054	1.433
So. American	1.3202	3.7851	1.816
Spaniard	1.4223	3.2459	1.191
Swede	2.1023	1.9293	1.464
Turk	.0000	6.4682	1.580

TABLE IV

Scale Values and Discriminal Dispersions Obtained through Paired Comparison, Order of Merit, and Successive Intervals Methods. Handwriting Study.

Specimen	Paired Com- parison	Order of Merit Law of Compar. Judgment	Order of Merit Data Method of Successive Intervals		Successive Intervals	
			S	σ	S	σ
B5	0.0000	.0000	0.0000	1.00	0.0000	1.00
G3	.4431	.4548	.5170	1.00	.4013	.90
H3	.4510	.6471	.7698	.81	.7009	.75
Y5	.4664	.8593	.8803	1.02	.6748	.99
F4	.5548	.6160	.7355	.85	.4574	.84
K2	.6679	.4336	.4677	1.03	.2614	.94
T4	1.4315	.8041	.8709	1.02	.4982	.94
F2	1.7219	1.9442	1.8339	.74	1.4672	.72
N2	1.8829	2.6589	2.5377	.90	1.9696	.83
B4	2.4637	2.8801	2.6603	.87	1.8902	.85
T3	3.2037	4.2595	3.8441	.82	2.8301	.77
Z3	3.3046	3.7929	3.5152	.81	2.6025	.82
J2	3.5206	4.2171	3.8605	.78	2.8045	.76
X3	4.3280	4.9039	4.4015	.79	3.0676	.77
R2	4.4369	5.4426	4.8556	.86	3.3676	.89
U3	5.5504	6.8529	6.0383	.62	4.0846	.75
A4	5.5302	6.7741	6.0072	.67	4.0490	.79
G4	5.8731	7.3983	6.4716	.83	4.3592	1.08
J3	7.4342	8.2750	7.2430	.87	4.8075	.81
D2	7.6887	8.5833	7.6938	1.01		

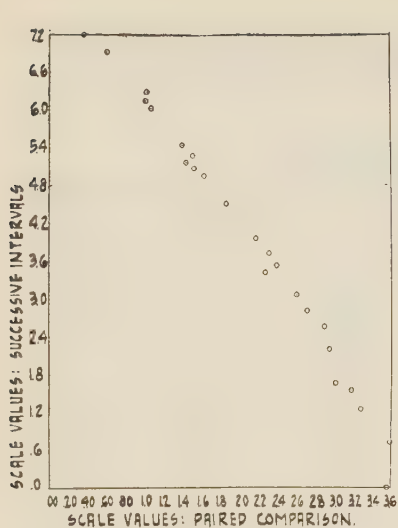


FIGURE I

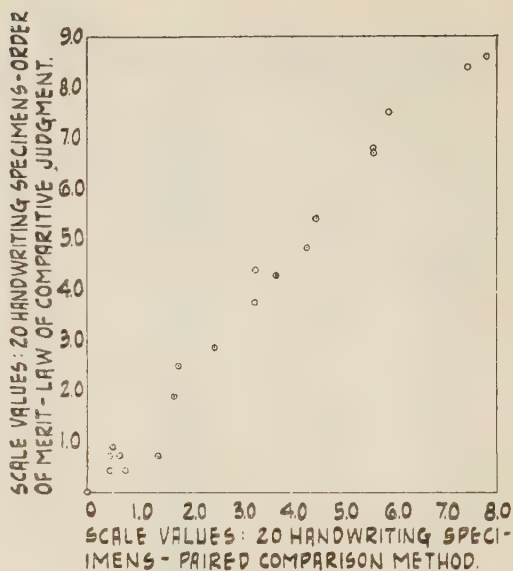


FIGURE II

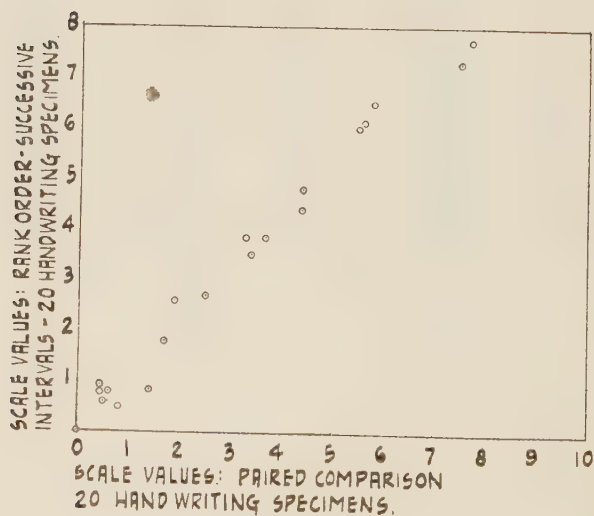


FIGURE III

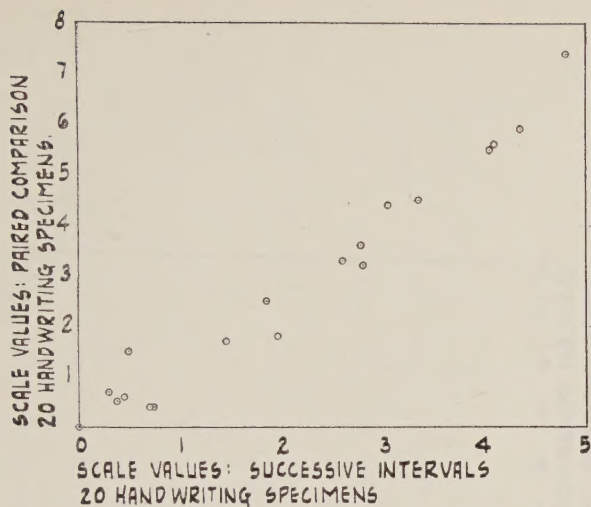


FIGURE IV

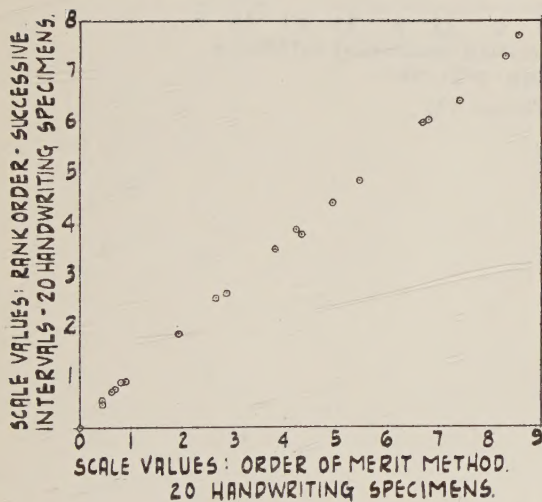


FIGURE V

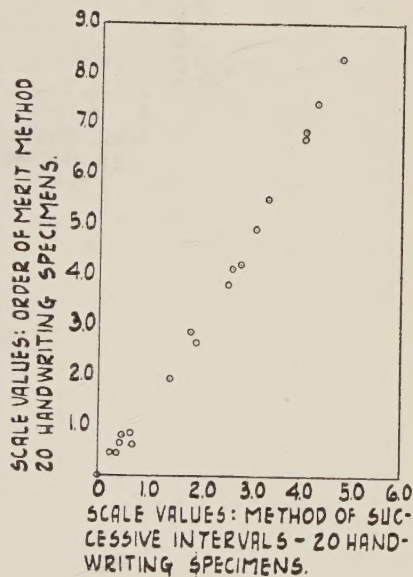


FIGURE VI

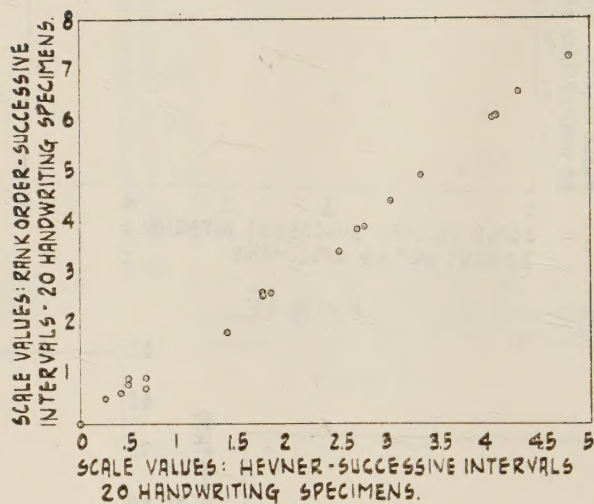


FIGURE VII

